CLAIMS

We claim:

1. A scanning X-ray inspection system, comprising:

a) a conveyor having a belt for moving an object to be scanned though said system;

b) an X-ray generation device for generating a pencil beam of X-rays repeatedly sweeping along a straight line across said conveyor, thereby scanning said object as it moves through said system, said X-ray generation device being disposed outside said belt;

c) a fast backscatter detector for generating a backscatter signal when detecting said X-rays backscattered by said object moving on said conveyor, said backscatter detector being disposed on the same side of said moving object as said X-ray generation device, outside said belt, and proximate to said straight line;

d) a transmission detector for generating a transmission signal when detecting said X-rays traversing said object moving on said conveyor, said transmission detector being positioned on the opposite side of said object as said backscatter detector, whereby said object moves between said transmission detector and said backscatter detector;

e) a processor for processing said backscatter and transmission signals for a display; and

f) a display means for displaying a backscatter image and/or a transmission image.

2. A system as recited by claim 1, whereby said fast backscatter detector comprises a scintillator having a short persistence phosphor and at least one photon detector.

3. A system as recited by claim 2, wherein said short persistence phosphor is either Gd_2SiO_5 or Y_2O_2Si.

4. A system as recited by claim 2, wherein said fast scattering detector comprises an organic plastic scintillator.

5. A system as recited by claim 1, said system being a tomographic system and further comprising a second fast backscatter detector positioned along said straight line and opposite from said fast backscatter detector.

6. A system as recited by claim 1, wherein said fast backscatter detector comprises two elongated scintillator sections optically linked to at least one photon detector, each of said sections being oppositely disposed along said straight line.

7. A system as recited by claim 1, said system being a tomographic system and further comprising a plurality of distal fast backscatter detectors for detecting X-rays scattered from the distal portion of said object, said distal fast backscatter detectors being disposed alongside said fast backscatter detector whereby said fast backscatter detector is positioned between said straight line and said distal fast backscatter detectors.

8. A system as recited by claim 1, wherein said processor is switchable between photon counting and photon integration modes.

9. A system as recited by claim 7, wherein said processor is automatically switchable between photon counting and photon integration modes.

10. A system as recited by claim 1, whereby said transmission detector comprises a scintillator having a short persistence phosphor and at least one photon detector.

11. A system as by claim 10, wherein said short persistence phosphor is either Gd_2SiO_5 or Y_2O_2Si.

12. A system as recited by claim 10, wherein said fast scattering detector comprises an organic plastic scintillator..

13. A system as recited by claim 1, whereby said transmission detector comprises three elongated sections optically linked to at least one photon detector, said sections being linked to form three sides of an open rectangle.

14. A fast backscatter detector for use in a tomographic scanning X-ray inspection system, comprising an organic plastic scintillator having an exit end and a photomultiplier tube mounted at said exit end, and said end being shaped to project light into said photomultiplier tube.

15. A fast backscatter detector as recited by claim 14, wherein said end is cut at a 45 degree angle.

16. A transmission detector for use in a tomographic scanning X-ray inspection system, comprising an organic plastic scintillator having the shape of a U and a photomultiplier tube mounted at one end of said U-shape, said one end being shaped to project light into said photomultiplier tube.

17. A transmission detector as recited by claim 16, wherein said one end is cut at a 45 degree angle.

18. A method for X-ray inspection of an object using transmitted and Compton backscattered radiation, comprising the steps of:

a) providing an X-ray source, a conveyor having a belt, a fast transmission detector, and a fast backscatter detector, said X-ray source and said fast backscatter detector being disposed on one side of said belt and said transmission detector being disposed on the other side of said belt;

b) generating a pencil beam of X-rays using said X-ray source;

d) transporting said object on said belt of said conveyor between said X-ray source and said transmission detector and through said pencil beam;

d) scanning said object with said pencil beam of X-rays;

e) detecting X-ray transmission through said object using said fast transmission detector;

f) selecting a detection mode for detecting said transmission X-rays, said mode being at least one of photon integration and photon counting;

g) detecting X-rays backscattered from said object using said fast backscatter detector;

g) selecting a detection mode for detecting said backscattered X-rays, said mode being at least one of photon integration and photon counting;

h) forming a transmission image from said detected transmission X-rays

i) displaying said transmission image;

j) forming a backscattered image from said detected backscattered X-rays; and

k) displaying said backscattered image.

19. A method as recited by claim 18, further comprising the steps of;

a) combining said backscattered image and said transmission image into a composite image; and

b) displaying said composite image.

20. A method as recited by claim 18, wherein said photon counting and photon integrating modes are combined and photon counting and photon integration are carried out simultaneously.

21. A system as recited by claim 1, wherein said conveyor has a belt and said system automatically adjusts the belt speed: (i) to allow rapid entrance into an inspection zone wherein said object is contacted by said pencil beam of X-rays; (ii) to slow

traverse through the inspection zone to prolong residence therein of said object; and (iii) to allow rapid exit from the inspection zone.

22. A system as recited by claim 1, further comprising at least one additional transmission detector overlaying said transmission detector for detecting high energy X-rays and transmitting them to said processor, said high energy X-rays being combined with the signal from said transmission detector to produce an information stream containing radiographic density and atomic number data.

23. A system as recited by claim 22, further comprising a filtering material disposed between said transmission detector and said additional transmission detector for increasing discrimination between X-rays having different energies.

24. A system as recited by claim 1, wherein said display means is operative to display each of said backscatter and transmission images, and said images displayed as adjacent windows on a single monitor.

25. A system as recited by claim 1, wherein said signal from said transmission detector is used to correct for attenuation effects in said backscatter image, thereby avoiding artifacts in the low Z images produced by attenuation due to high Z objects.

26. A system as recited by claim 1, wherein said signal from said backscatter detector is used to correct for scatter effects in said transmission image, thereby avoiding artifacts in the high Z image produced by scattering attenuation due to low Z objects.

27. A scanning X-ray inspection system, comprising:

a) a conveyor having a belt for moving an object to be scanned though said system;

b) an X-ray generation device for generating a pencil beam of X-rays repeatedly sweeping along a straight line across said conveyor, thereby scanning said object as it moves through said system, said X-ray generation device being disposed outside said belt;

c) a fast backscatter detector for generating a backscatter signal when detecting said X-rays backscattered by said object moving on said conveyor, said fast backscatter detector comprising a scintillator having a short persistence phosphor and at least one photon detector and being disposed on the same side of said moving object as said X-ray generation device, outside said belt, and proximate to said straight line;

d) a transmission detector for generating a transmission signal when detecting said X-rays traversing said object moving on said conveyor, said transmission detector comprising a scintillator having a short persistence phosphor and at least one photon detector and being positioned on the opposite side of said object as said backscatter detector, whereby said object moves between said transmission detector and said backscatter detector;

e) a processor for processing said backscatter and transmission signals for a display; and

f) a display means for displaying a backscatter image and/or a transmission image.